

SPECIFICATION AMENDMENTS

On page 1, insert above line 1, insert--Priority Claim

The present application claims priority on European Patent Application 02016090.9 filed 19 July 2002.--

On page 1, above line 1, insert--Field of the Invention--

Paragraph at line 1 of page 1 has been amended as follows:

-- The invention is related directed to a process for combustion of a liquid hydrocarbon fuel wherein the following steps are performed:

- (a) obtaining a mixture of liquid hydrocarbon droplets in an oxygen containing gaseous phase,
- (b) evaporating the liquid hydrocarbon droplets, preferably in a cool flame at a temperature of between 300 and 480 °C, to obtaining a gaseous mixture comprising oxygen and hydrocarbons, and
- (c) total combustion of the gaseous mixture obtained in step (b).

On page 1, above line 12, insert--Background of the Invention--

Paragraph at line 12 of page 1 has been amended as follows:

--Such a process is described in detail in High Modulation Burner for Liquid Fuels Based on Porous Media Combustion and Cool Flame Vaporization; D. Trimis, K. Wawrzinek, O. Harzfeld, K. Lucka, A. Rutsche, F. Haase, K. Krüger, C. Küchen, Sixth International Conference on Technologies and Combustion for a Clean Environment (Clean Air VI), Vol. 2, Paper 23.1, Porto, Portugal, 9-12 July 2001. This article describes a so-called porous burner, which comprises means to mix air and a liquid fuel, a space for evaporating the liquid fuel in a cool flame, and a space filled with a porous material in which the combustion of the air/evaporated fuel mixture takes place. As a possible liquid fuel Industrial Gas Oil is mentioned in this article. Means to de-sulphurise de-sulfurize the exhaust gas are also present, e.g. in a water-bath. Typical for these types of burners is that they are very suited for low power applications in the range of 2 to 30 kW. This makes

them very suited for domestic applications such as domestic heating or boiler applications. A further advantage is these types of burners allow a high power modulation of more than 1:10. This allows a reduction of start/stop events with its associated temporally higher emissions of hydrocarbons and carbon monoxide.--

Paragraph at line 16 of page 2 has been amended as follows:

-- ~~The objective of the present invention is therefore It would be useful to provide a process, which does not have such a disadvantage. This object is achieved with the following process.~~--

On page 2, above line 20, insert--Summary of the Invention--

Paragraph at line 20 of page 2 has been amended as follows:

--The invention is directed to a process ~~Process~~ for combustion of a liquid Fischer-Tropsch derived hydrocarbon fuel wherein the following steps are performed:

- (a) obtaining a mixture of liquid hydrocarbon droplets in an oxygen containing gaseous phase,
- (b) evaporating the liquid hydrocarbon droplets to obtaining a gaseous mixture comprising oxygen and hydrocarbons, and
- (c) ~~total combustion of~~ combusting completely the gaseous mixture obtained in step (b).

On page 2, above line 30, insert--Detailed Description of the Invention--

Paragraph at line 30 of page 2, ending at line 5 of page 3, has been amended as follows:

-- Applicants found that by using a Fischer-Tropsch derived fuel a better evaporation takes place in the cool flame. This has resulted in a better combustion, improved flame ignition and less fouling of any downstream heat exchanger surfaces. Furthermore because Fischer-Tropsch derived fuels contain almost no sulphur sulphur no special measures have to be provided to clean the flue gas of said combustion or to apply special non-corrosive materials.--

Paragraph at line 6 of page 3 has been amended as follows:

--In step (a) a mixture of liquid Fischer-Tropsch derived fuel droplets in a gaseous continuous phase is prepared. The gaseous phase will contain oxygen or any other oxidant. The gaseous phase is preferably air. The preparation of said mixture may be performed by different techniques. For example, a mixture is obtained by passing a mixture of air and liquid fuel through small openings at a certain pressure difference resulting in the formation of the small liquid droplets in the gaseous phase. A second technique is by atomization of the liquid fuel through ultrasonic vibrations as for example described in US-A-US-Pat No.4264837. A preferred method is wherein the liquid fuel is first atomised atomized by means of a spray nozzle and subsequently mixed with air as, for example, described in the above-cited article. --

Paragraph at line 21 of page 3 has been amended as follows:

--The size of the droplets will be determined by the method chosen. In the case of a nozzle, the dimensions of the nozzle, the fuel feed rate, fuel oil pressure, fuel viscosity (and, therefore, temperature of the fuel) and surface tension will influence the droplet size. Smaller droplets and thus a better evaporation of the liquid fuel will be achieved at higher fuel feed rates and/or higher oil pressures for a given feed nozzle. Preferably, the droplet size is as small as possible. However, the high pressures needed to obtain such small droplets may be not be economically or technically feasible. Applicants have found that when using Fischer-Tropsch derived fuel, larger droplets may be allowed without negatively affecting the combustion. This is very advantageous because now a lower oil pressure may be applied which makes the combustion process technically more simple simpler and more energy efficient.--

Paragraph at line 5 of page 4 has been amended as follows:

-- The oxygen containing gas will normally be air. However, other sources of oxygen containing gases such as purified oxygen could also be used. For the remainder of this description reference shall be made to air, thereby not excluding the alternative sources. The excess air ratio in the present process is preferably between 1.1 and 3 (excess air ratio is defined as the ratio between the actual air supply and the needed air for stoichiometric

combustion of the fuel ($\lambda=1$). The liquid fuel is preferably introduced into the air as a fine spray of droplets.--

Paragraph at line 16 of page 4, ending at line 5 of page 5, has been amended as follows:

-- Step (b) is preferably performed by means of a so-called cool flame. Cool flames, sometimes also referred to as cold flames, start at a temperature of 300 °C and stabilize, virtually independent of the air ratio, at a temperature of 480 °C at 1 bar conditions. A cool flame will be formed when at a certain minimum temperature (300 °C). If the temperature is kept below 480 °C no auto ignition will occur because the needed activation energy is too high under these conditions. This temperature is suitably maintained by means of indirect heat exchange against either hot exhaust gasses or against the combustion zone. In the cool flame, the liquid droplets will evaporate thereby forming a gaseous mixture that is used in step (c). Steps (b) and (c) in the method according to the present invention are physically separated. Preferably, measures are taken to avoid prevent hot combustion gases from step (c) to enter from entering the area wherein the cool flame is present. Examples of such measures are flame traps through, for example, flow acceleration or metal grids positioned at the physical interface between step (a) and step (b). Examples of cool flames are described in the above referred to article and in EP-A-947769. --

Paragraph at line 6 of page 5 has been amended as follows:

-- Alternatively, steps (a) and (b) may be performed by first evaporation evaporating of the fuel and subsequently mixing the gaseous fuel with the oxygen containing mixture, or by evaporation evaporating in an inert medium before mixing with the oxygen containing gas.--

Paragraph at line 11 of page 5 has been amended as follows:

-- The combustion in step (c) may be performed in different manners. For example, aerodynamic stabilization of the flame may be applied. More preferably, the flame is positioned by means of a porous surface, wherein the mixture is provided to one end of said surface and a flame is present just down stream of said surface. An example of such a surface burner is described in EP-A-947769. --

Paragraph at line 19 of page 5 has been amended as follows:

-- Another preferred embodiment for step (c) is wherein the combustion takes place in a porous material as, for example, described in the above referred to article. The porous material may be as described in the above-described article or as in US-A-Pat No. 5522723. It has been found important that combustion process may take place inside the porous structure. Pores that are too ~~Too~~ small pores will quench the flame and pores that are ~~are~~ too large pores will cause flame propagation. Preferably, the porous material is comprised of a first zone wherein flame propagation is suppressed, the so-called pre-heating zone, and a second zone wherein flame propagation is possible, the actual combustion zone. The porous material may be made from, for example alumina, zirconium oxide or silicium carbide.--

Paragraph at line 1 of page 6 has been amended as follows:

--In step (c), preferably, a flame detector is used. Examples of suitable detectors are the UV sensors and IR sensors. A more preferred detector is the so-called ionisation ionization sensor. An ionisation ionization sensor is suitable to monitor burners with intermittent operation as well as continuous operation. The principle of operation of the ionisation ionization flame monitor is based on the rectifying effect of a flame. If a flame is present, a current flows between the burner and the ionisation electrode. This ionisation ionization current is evaluated by the flame monitor to determine if a flame is present. In some prior art applications, ionisation ionization sensors could not be used in combination with a liquid fuel because deposits in the sensor led to false currents in the sensor. Because use of the Fischer-Tropsch derived fuel, especially a fuel composition not containing a metal based combustion improver, results in less fewer deposits, ionisation ionization sensors ~~can~~ may be applied. Examples of metal based combustion improvers are ferrocene based additives and methylcyclopentadienylmanganese-tricarbonyl (MMT). This is an advantage because these sensors are more readily available than the IR or UV sensors.--

Paragraph at line 23 of page 6 has been amended as follows:

-- The Fischer-Tropsch derived fuel ~~will~~ may comprise a Fischer-Tropsch product which may be any fraction of the middle distillate fuel range, which can be isolated from the (hydrocracked) Fischer-Tropsch synthesis product. Typical fractions will boil in

the naphtha, kerosene or gas oil range. Preferably, a Fischer-Tropsch product boiling in the kerosene or gas oil range is used because these products are easier to handle in, for example, domestic environments. Such products will suitably comprise a fraction larger than 90 wt% which boils between 160 °C and 400 °C, preferably to about 370 °C. Examples of Fischer-Tropsch derived kerosene and gas oils are described in EP-A-583836, WO-A-9714768, WO-A-9714769, WO-A-011116, WO-A-011117, WO-A-0183406, WO-A-0183648, WO-A-0183647, WO-A-0183641, WO-A-0020535, WO-A-0020534, EP-A-1101813, US-A-Pat No. 5766274, US-A-Pat No. 5378348, US-A-Pat No. 5888376 and US-A-Pat No. 6204426.--

Paragraph at line 7 of page 7 has been amended as follows:

-- The Fischer-Tropsch product will suitably contain more than 80 wt% and more suitably more than 95 wt% iso and normal paraffins and less than 1 wt% aromatics, the balance being naphthenics compounds. The content of sulphur sulfur and nitrogen will be very low and normally below the detection limits for such compounds. This The low content of these elements is due to the specific process wherein the Fischer-Tropsch reaction is performed. The content of sulphur sulfur will therefore be below 5 ppm and the content of nitrogen will be below 1 ppm. As a result of the low contents of aromatics and naphthenics compounds the density of the Fischer-Tropsch product will be lower than the conventional mineral derived fuels. The density will be between 0.65 g/cm³ and 0.8 g/cm³.-

Paragraph at line 21 of page 7 has been amended as follows:

-- The fuel used in the process of the present invention may also comprise fuel fractions other than the Fischer-Tropsch product. Examples of such fractions may be the kerosene or gas oil fractions as obtained in traditional refinery processes, which upgrade crude petroleum feedstock to useful products. Preferred non-Fischer-Tropsch fuel components are the ultra low sulphur sulfur (e.g. less than 50 ppm sulphur sulfur) kerosene or diesel fractions, which are currently on the market. Optionally non-mineral oil based fuels, such as bio-fuels, may also be present in the fuel composition. The content of the Fischer-Tropsch product in the fuel will be preferably be above 40 wt%, more preferably above 60 wt% and most preferably above 80 wt%. It should be understood that the content of such, currently less available, Fischer-Tropsch product will be optimised optimized, wherein pricing of the total fuel will be balanced with the advantages of the present

invention. For some applications, fuels fully based on a Fischer-Tropsch product plus optionally some additives may be advantageously used.--

Paragraph at line 8 of page 8 has been amended as follows:

-- The fuel may also comprise one or more of the following additives: detergents Detergents, for example OMA 350 as obtained from Octel OY; stabilizers, for example Kerpon ES 3500 as obtained from BASF Aktiengesellschaft, FOA 528A as obtained from OCTEL OY; metal-deactivators, for example IRGAMET 30 (as obtained from Specialty Chemicals Inc; (ashless) dispersants, for example as included in the FOA 528 A package as obtained from Octel OY; anti-oxidants: IRGANOX L06, or IRGANOX L57 as obtained from Specialty Chemicals Inc ; cold flow improvers, for example Keroflux 3283 as obtained from BASF Aktiengesellschaft, R433 or R474 as obtained from Infineum UK Ltd; anti-corrosion: Additin RC 4801 as obtained from Rhein Chemie GmbH, Kerocorr 3232 as obtained from BASF, SARKOSYL 0 as obtained from Ciba; re-odorants, ~~fre-for~~ example Compensol as obtained from Haarmann & Reimer; biocides, for example GROTA MAR 71 as obtained from Schuelke & Mayr; lubricity enhancers, for example OLI 9000 as obtained from Octel; dehazers, for example T-9318 from Petrolite; antistatic agents, for example Stadis 450 from Octel; and foam reducers, for example TEGO 2079 from Goldschmidt. It has been found that the Fischer-Tropsch derived fuel does not necessarily have to contain a combustion improver such as for example ferrocene or MMT.--

Paragraph at line 1 of page 9 has been amended as follows:

-- The Fischer-Tropsch product is ~~colourless~~ colorless and ~~odourless~~ odorless. For safety reasons an odour marker, as for example applied in natural gas for domestic consumption, may be present in the Fischer-Tropsch derived fuel. Also a ~~colour~~ color marker may be present to distinguish the fuel from other non-Fischer-Tropsch derived fuels.--

Paragraph at line 7 of page 9 has been amended as follows:

-- The total content of the additives may be suitably be between 0 wt% and 1 wt% and preferably below 0.5 wt%.--

Paragraph at line 9 of page 9 has been amended as follows:

-- The combustion process using the Fischer-Tropsch fuels is preferably applied for domestic heating, wherein the heat of combustion is used to heat water by indirect heat exchange in so-called boilers. The process is especially suited for domestic applications because of its power modulation range of between 2 kW and 30 kW. The heated water may be used to warm up the house or consumed in, for example, showers and the like.--

Paragraph at line 17 of page 9, ending at line 3 of page 10, has been amended as follows:

-- The combustion process using the Fischer-Tropsch fuels may advantageously be further used for direct heating of large spaces. Such applications are characterized in that the flue gasses are directly supplied to said space to heat up said space. Spaces such as tents and halls are often heated up with such an apparatus. Normally gaseous fuels for example natural gas, LPG and the like, are used for this application because the associated flue gasses can be safely supplied to said space. A disadvantage of the use of gaseous fuels is, however, that handling of the pressurized gas containers and combustion equipment requires professional skills in order to operate such an apparatus safely. By using a Fischer-Tropsch derived liquid fuel a comparable flue gas is obtained in the combustion process as when a gaseous fuel is used. Thus, a method is provided wherein a liquid fuel can be applied for direct heating of spaces. The application of the liquid Fischer-Tropsch derived fuel makes the use of the apparatus for direct heating much more simple and safe.--

Paragraph at line 4 of page 10 has been amended as follows:

-- The direct heating of spaces is preferably performed by means of a so-called radiation heater. In such an apparatus, step (c) is preferably performed at or in the surface of a perforated plate. This plate is preferably a ceramic plate. In this plate, combustion will take place in the short channels across the plate. The combustion heat will result in a glowing plate generating radiation energy that will heat up the surrounding air. Typically the fuel for such radiation heaters is a gaseous fuel because the flue gasses will also be emitted in the surrounding air. Applicants have now found that also a Fischer-Tropsch fuel may also be advantageously applied without the disadvantages of a liquid fuel. Examples of radiation heaters which normally operate on a gaseous fuel but which now can be operated on a liquid fuel are described in US-A-Pat No. 5139415, EP-A-0949452 or EP-A-0037046.--

On page 10, delete line 20-33.

On page 11, delete line 1-3.

Paragraph at line 4 of page 11 has been amended as follows:

-- The process may also be advantageously applied in a process to generate steam, particularly ~~Especially~~ when step (c) is performed in a porous material as described in for example US-A-Pat No.5522723. The heat of combustion generated by such process ~~can~~ may be used to generate steam, which may be used for various purposes, such as heating. A preferred application is described in US-A-Pat No.2002194848 and WO-A-03036072, wherein said generated steam is first super heated and subsequently fed to a piston engine or an expansion engine. This application is sometimes also referred to as the SteamCell of Enginion AG (SteamCell is a trademark). The engine may provide mechanical power, for example to power an automobile, or electricity. The claimed advantage of this type of engine is low NO_X emissions as compared to the state of the art combustion engines. By using a Fischer-Tropsch derived fuel NO_X emissions may be further reduced in such an application. An additional advantage is that the Fischer-Tropsch derived fuel is practically ~~sulphur~~ sulfur free. This can further simplify the design of the burner and reduce the complexity of such an engine.--

On page 12, above line 1, insert --We claim:--